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[The Association as a body is not responsible for statements or opinions of any of its members.]

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THE MASSACHUSETTS ASSOCIATION OF BOARDS OF HEALTH was organized in Boston, March, 1890, with the following objects: The advancement of sanitary science; the promotion of better organization and co-operation among local boards of health, and the uniform enforcement of sanitary laws and regulations.

THE JOURNAL OF THIS ASSOCIATION has for fifteen years faithfully reflected the views of the public hygienists of Massachusetts. With the November issue of the year 1904, the encouragement received from many hygienic quarters induced the Association to undertake the expansion of the Journal to a national standard, with the co-operation of many noted sanitarians as editors. A new title was selected, while the older and well-established title was retained also.

The dates of publication are FEBRUARY, MAY, AUGUST and NOVEMBER of each year.

THE JOURNAL will contain the papers read at the meetings of the Association, papers contributed by hygienists, report of the discussions, editorials, abstracts, reviews and hygienic notes of professional interest. Subscription rates, $1.00 per year. Reprints furnished at cost price.

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All communications concerning the ASSOCIATION should be addressed to the Secretary of the Association, JAMES C. COFFEY, CITY HALL, WORCESTER, MASS.

All bills not relating to the Journal, and MEMBERSHIP DUES ($2.00 per year), should be sent to the Treasurer of the Association, DR. JAMES B. FIELD, 329 WESTFORD ST., LOWELL, MASS.

APRIL QUARTERLY MEETING

OF THE

Massachusetts Association of Boards of Health

The quarterly meeting of the Association was held at the Brunswick Hotel, luncheon being served at one p. m. After the luncheon the exercises were as follows, Dr. H. P. Walcott presiding.

THE CHAIRMAN: Gentlemen, the meeting will please come to order. Will the Secretary read the records of the last meeting?

(The Secretary read the minutes of the last meeting.)

THE CHAIRMAN: Is there any change to be made in this record? If not, it will stand as the record of the last meeting of this society. The Executive Committee recommend to the society the election of the following persons:

Dr. Chas. F. Atwood, Arlington.
Dr. James J. Scannell, Boston.
William H. Hayes, Boston.
Dr. Geo. Westgate Mills, Medford.
Dr. Frederick R. Ilsley, Medford.
Geo. Royal Pulsifer, Newton.
Miss Elizabeth S. Mason, Smith College, Northampton.
Miss Evelyn B. Sherrard, Wellesley College, Wellesley.
Miss Elizabeth A. Wright, Radcliff College, Cambridge.
Miss Mary E. Trueblood, Mt. Holyoke College.

Is it your pleasure that these persons be elected to membership in the society? If so, you will indicate it by saying "Aye."

(Response, "Aye.")

Contrary minded, no. They are duly elected. Is there any business to come before the society at this time? If not, the first paper upon our programme is a paper upon "The Gypsy and Brown-tail Moths; Their Life Histories and Some Sug-

gestions for Their Suppression," by Prof. William Lyman Underwood. Mr. Underwood hardly needs an introduction to this audience.

SOME PERSONAL EXPERIMENTS WITH THE GYPSY AND BROWN-TAIL MOTH PESTS.

Prof. William Lyman Underwood.

Mr. President and members of the Association: One can scarcely pick up a newspaper nowadays without seeing in it some reference to the gypsy and brown-tail moth plague, as I may term it,—two pests which in this section of Massachusetts have made life at certain times of the year almost, if not quite, unbearable. In spite of all the information which has been published on this subject there are many people who do not know the difference between the brown-tail moth and the gypsy moth. They don't know really what these insects are capable of doing; they don't know about their life histories. Many persons do not seem to pay much attention to the subject; they wait until the brown-tails or the gypsies get upon their own places or upon their trees and strip the foliage and then they begin to look into it. I can speak quite feelingly on this matter because I was one of that class of people myself. I didn't pay very much attention to this question. I live in Belmont where for many years we did not have any gypsy moths, but last year we began to have them quite plentifully and in order to protect my own trees, of which I have some three hundred, I had to inform myself on the subject. I am going to tell you this afternoon what I found out in a small way and try to give you some information whereby those of you who have small places can look after your own trees and perhaps can tell others how to take care of theirs.

Now, if you will have the lights put out I will show the photographs which I have taken to illustrate my points. I shall first take up the gypsy moths.

If one walks out through an infested district in the fall or

during the winter or even now, he will see on the trees something like this. These are the egg clusters of the gypsy moth; unless it is a very thickly infested section, you will not see the clusters as close together as these are. They are generally on the under side of limbs, out of the sun, for the moths and the caterpillars do not like the sunlight and always seek the shade. Each of these clusters contains from two to four or five hundred eggs. They are just this yellow color when they are laid, but later on, especially if the sun beats upon them, they will change in color and become faded out to a dirty white, especially at this time of year. Now, we will examine more closely one of these egg clusters. In reality they are about an inch and a half long, covered with creamy yellow hair, which the female puts upon each of the eggs as she lays them. The eggs are covered with a sticky gelatinous substance, to which the hairs readily adhere. We will take a knife and scrape away the surface of one of these clusters and then you can see the individual eggs closely packed together with the hairs which are taken from the body of the female sticking to them. In reality these little eggs are about the size of the head of a pin and are of a pinkish color. As I said, each egg cluster contains on an average from two to three or four hundred eggs. No matter how cold or severe the winter, unless these egg clusters have been properly treated, when this time of the year comes or a little bit later, they will begin to hatch out. Last year (1905) I saw the first caterpillars crawling about on the 22nd of April.

If you should walk along by a pasture wall through an infested district you at first would not notice many egg clusters, owing to the fact that the caterpillars have crawled in under the wall and pupated and the moths have laid their eggs out of sight in the shade. But pull out a stone and turn it over and this is what you would probably see—great numbers of egg clusters covering the stone. This was the under side of the stone before I pulled it out, and many of these other stones in the wall were in the same condition, having a great

many egg masses upon them. Any one going along and taking merely a superficial examination would not have seen them. Now, a stone wall is a pretty hard thing to treat. Of course, the best thing to do is to point it, fill it up with cement, but that is an expensive job and there are not many farmers who can afford to do it. The next best thing is to sell the stone and that can be quite easily done in this section because the stone is valuable. By putting up wire fences instead of stone walls the farmer can easily overcome this difficulty, for the moths will not lay their eggs upon wire fences. If, however, you do not want to get rid of your wall and you cannot cement it and don't want to sell it, the next best thing is to wait until about this time of the year, or a little later, when the caterpillars begin to crawl out, and then set fire to the grass around the base of the wall and blow a flame of gasolene or kerosene into all the openings. That will kill the little caterpillars very readily. If you were to hold a torch under one of these egg clusters for quite a while you would not do very much damage. After a few minutes you would hear some of the outer eggs pop, as they expanded with the heat, but those of the inside of the cluster would not be affected. But by waiting until the caterpillars crawl out they can be very easily destroyed. Mr. Kirkland has told me of another way of destroying the caterpillars on stone walls, but he will speak about that when he tells you of his larger field work.

The caterpillars go into all sort of out-of-the-way places where they pupate. You will find them in old tin cans out on the dump; they will crawl up the spout of a rain water conductor; they will get under the eaves, under the piazza, and into all sorts of places. This picture shows you one out-of-the-way place where some of them crawled. It is an old-fashioned New England iron kettle, one of the kind where the cover swings off to one side and does not tilt back. The caterpillars had crawled in through the spout, and the mother laid their eggs in there, and you can see along the edge where the eggs of the moths were laid and where they were torn

away when the lid was pulled off to one side. There were thousands and thousands of eggs in that kettle, and if they had not been discovered great numbers of caterpillars would have crawled out the next spring. To give you a further illustration to show where the moths and caterpillars may go and in what strange places we may find them, I had a good deal of trouble in persuading these insects to keep still while I took their picture. In making some experiments with them I had a member of my family to assist me and he was trying to devise some way to make the moths keep still while they were having their pictures taken. He had one particularly fine specimen of gypsy moth which got away from him. That night after retiring he felt something uncomfortable under his collar, and on investigating he found this individual moth. After he had removed the moth he returned to bed, but still felt uncomfortable, and upon further investigation found quite a number of eggs which the moth had laid adhering to one of his shoulder blades. Still further than this, I had occasion one day to consult a volume which was published by the Gypsy Moth Commission—and a very excellent volume it is—on the gypsy moth problem. It was in a bookcase, and when I took the volume down I was astonished to find on the top of it a gypsy moth chrysalis or pupa. The caterpillar had apparently, in defiance of the Commonwealth of Massachusetts, crawled up the back of this book and pupated on the top of it. A number of times afterwards we found pupae and moths in out of the way places through the house.

This picture shows you the little caterpillars as they are coming from the egg clusters in the spring. It was taken on the 22nd of last April, the first day that I saw them out. I believe that in some warm places this year the caterpillars have now begun to crawl from the eggs. It makes no difference how cold the winter may be, they will come forth in the spring if the clusters have not been treated as they ought to be with creasote. These little caterpillars do not eat very much for a few days. They stay around the places where

they have been born, and then they begin to go out on the foliage. When they are small they are not so very ravenous. They eat only the tender hairs and outer skin of the leaves at this age. In this photograph, taken on June 5th, the caterpillars are half an inch long, and are not very prominently marked. They are of a dirty grayish color, with long black hairs and a rather large head. As they grow they shed their skin or moult five or six times until they come to their full size. From now on they increase in size much faster, and here we see the full-grown caterpillars upon an elm leaf. They are now about three inches long, and can be easily distinguished from the other caterpillars by this double row of red and dark blue spots. Beginning at the tail, there are six rows of red spots and five rows of blue spots. There is no other caterpillar in New England which has this double row of red and blue spots. At this stage they eat about everything they come across. All foliage is good food to them.

After a short time, when they are full grown, they change from the caterpillar or larva into the pupa or chrysalis. They begin to thicken up a little, they get shorter and thicker, and spin a few threads of silk, by which they hang, from the tail, and now they begin to twitch and soon split here at the shoulder and the pupa comes out. At first it is of a delicate pink color, but it soon changes to a brown—to different shades of brown, and sometimes almost black. Here you see an empty caterpillar skin, and this is the pupa. There is some difference in size among the pupae, but as a general thing the larger ones are the females and the smaller ones are the males. Here as the pupae they stay from eight to ten or fourteen days, acording to the temperature. If it is warm, the process will be hastened, but if it is cold it will be prolonged. Then from the chrysalis or pupa the moth emerges.

In this picture we see a large group of moths upon a limb of an apple tree, and there were many limbs on many trees on this estate which looked like this. The farmer who owned

this place—and it was right across the street from my home —was a newcomer into this section of Massachusetts. He saw these golden egg clusters on the trees in the fall and he knew something had got to be done, so he got a hoe and hoed them down and he did what he thought was a pretty good piece of work. He scraped all the egg clusters off on to the ground and thought that he had done away with them. Much to his disgust and astonishment, the following year there were ten times as many caterpillars and gypsy moths about his place as there had been the year before. Of course, his work was thrown away. He had merely hoed them down onto the ground, where the eggs hatched out nearly as well as if they had been on the trees.

All the moths in this picture are females, and most of them are beginning to lay their eggs, as you see. Here are the empty pupa skins from which they have crawled. The next picture shows us the gypsy moths a little nearer and a little larger. They are just this creamy yellowish color when they come from the pupa, although this color may change quite rapidly if the sun shines upon them. Here is one which has faded out considerably, showing it has been longer in the sunlight than the others.

The female moths crawl but very few inches away from the place where they have been born. The females cannot fly, and it is owing to this fact, that in the nearly forty years that they have been here they have not spread over a much larger territory than they have. This moth came from this chrysalis here, just about an inch away, and here is the chrysalis from which this moth came.

This picture might be a little misleading because it shows gypsy egg clusters upon leaves. This rarely occurs. They do not very often lay their eggs upon the foliage, but generally on trees or upon fences, and in secluded places out of the sun. Let me stop a moment just to call your attention to this brown-tail moth and show you how different it is from this gypsy. It is much smaller and it pure white; but I will call

those points of difference to your attention in some other pictures later on.

This shows you a photograph taken on the top of Arlington Heights about two years ago. Last year the condition was even worse than this. As far as you could see, looking towards Winchester and Burlington, there was scarcely a leaf left on the trees. All of the deciduous trees and many of the conifers or evergreens were completely stripped. About a quarter of a mile below this place was a large patch of poison ivy, and even that was stripped of its leaves. The deciduous trees can generally stand having their foliage eaten for several seasons. Sometimes one season will seriously injure them, but if the soil is good they may be stripped time and time again before they are killed. On the other hand, if an evergreen or coniferous tree is once thoroughly stripped, it will not recover. There were many pines in this locality that were stripped and killed. The caterpillars do not care particularly for the white ash, and here is a white ash tree which you see still has a little foliage upon it, but later it, too, was eaten off. Here is a spruce hedge in the town of Medford, which has been stripped, it isn't good for anything except for fire-wood. The photograph was taken last August. A year ago at this time it was a very fine hedge, but now its beauty has gone, never to return. The foliage had also been stripped from these maple trees and from the apple trees, but you see it has come out again.

The thing to do with these egg clusters—the thing to have done, for it is too late to do it now—is to cover them with some substance which will prevent the eggs from hatching. The best thing to use is creosote oil, which can be bought for 35 cents a gallon, if it is purchased in large quantities. It should be applied to the egg clusters with a stiff brush, preferably a stencil brush which has good stiff bristles. An ordinary paint brush will hardly do. Sometimes I have seen people take a paint brush and paint over the egg clusters. That will kill the eggs on the outside, but not on the inside.

The material must be rubbed in. You can readily tell what nests have been treated with the oil, because after it has been applied they turn black. The oil should be applied just as soon as the foliage goes off in the fall. Of course, it can be done any time during the winter, but it is better to have the work done before the snow comes.

If you have treated your place properly and applied the creosote faithfully to all the egg clusters and later on when the caterpillars begin to crawl, they come over to your place from some neighbor who has not done the work which he ought to do, you can keep them from going into your foliage by putting around the trees some sticky preparation. In order to apply the preparation it is necsssary to get a smooth surface on the bark of the tree, and great care should be taken not to scrape the bark too deep, or the tree will be injured. Some trees like the birch or the beech may not need to be scraped at all, because the bark is smooth enough. There are several substances on the market which are used for this purpose and some of them are distinctly injurious to trees. There is one material which I have used with good results—last year I applied it to two hundred trees and I shall put it on three hundred trees this year,—and that is "Tanglefoot." In the Middlesex Fells last season the Metropolitan Park Commission used something over two tons of this substance and banded over sixty thousand trees. This year they will use over ten tons of it. "Tanglefoot" is the same material that is put on sticky fly-paper, but for moth destruction it comes in bulk in cans. It costs twenty-five cents a pound at retail, or it can be bought at a less price if you buy large quantities. It comes in five, ten or 25-pound cans. You can take it from the cans and put it on a mortar board, and then with a wooden chisel or trowel, put it on the trees. The caterpillars, both of the brown-tail moths and gypsy moths, cannot climb over this material. They do sometimes get over it in badly infested districts. I have seen the trunks of the trees so thickly covered with caterpillars that you could

scarcely see the bark. In such a case, when the caterpillars are so crowded, they may crawl onto and stick to the band and over their dead bodies the other caterpillars will crawl, just as the Japanese did in storming Port Arthur, and eventually they will get up the tree. But that is only in rare cases. Where they are so thick as this if we spray them with kerosene or gasoline in a fine spray they can be killed by the thousands and will drop to the ground as though struck by lightening. The "Tanglefoot" should be put on now, before the caterpillars begin to crawl.

This picture shows you the good effect of "Tanglefoot." It was taken out in Middlesex Fells. On this side of the road you can see the trees are perfectly protected and the foliage is in good condition. The trees on this side have not got a leaf on them. Nothing was done to them except what was done by the caterpillars, and they did their work very well, as you see.

There is still another way to protect your premises from these caterpillars,—a way which was adopted last year out in Middlesex Fells. In certain sections there, where they wanted to keep the caterpillars out, they put on the ground this windrow of hay and kept it saturated with crude kerosene. This fringe of hay was two miles long, and they had altogether some four miles which was kept wet with kerosene. Not a caterpillar of either variety can crawl through it and live. Sometimes they may squirm out for two or three feet, but they are sure to die, after a drop of oil has touched them.

There is still another way by which you can rid your premises of the caterpillars, and that is by spraying. Until last year I thought—in fact, it was commonly supposed—that there wasn't much good in spraying for full-grown gypsy caterpillars, because they seemed to grow fat on everything that was used. They did on Paris Green, so I was told. The farmers who sprayed with Paris Green did not seem to get very good results. In the last part of July I came home, after a three weeks' absence, and I found my hemlock hedge, about

three hundred feet long and seven feet high, looking ragged and thin. On close examination I found that it was full of gypsy caterpillars. I thought I had gone over my grounds very thoroughly during the winter, but when there are many egg clusters in a hedge like this it is hard to get them all. I creosoted many hundreds of them in the hedge, but it seemed there were quite a number left. We didn't know what to do. We picked off something like six hundred in less than half an hour, and then gave it up as a bad job. I telephoned to a forester and entomologist whom I knew and asked if there was anything that could be done. He said that two months ago he would have told me that it would be a pretty hard thing to save the hedge, but lately he had been using a preparation of arsenate of lead with good success. To make a long story short, he came over and sprayed the hedge, using arsenate of lead, fifteen pounds to 100 gallons of water, and for $1.80 the hedge was saved. In three days there wasn't a live caterpillar on it. Arsenate of lead makes a white deposit on the leaves which readily adheres to them, and although this hedge was sprayed on the 3rd of July you could still see some of it during last winter. Even if it should rain within two or three hours after spraying, the rain would not wash it off, as is often the case with Paris Green. Arsenate of lead is not a desirable thing to have near any food material, and if you have any fruit or vegetables near by it is well to cover them up before spraying. This preparation should be put on as a thin spray, just as near a fog or mist as you can get it. It is better to begin at the top of the trees and let the wind gently blow it on the foliage. Stop spraying as soon as it begins to drop off the leaves as then you are losing your material. On an average, this work can be done at about one dollar for each full-grown elm tree.

Here you may see the good effect of spraying. Here is a gentleman's estate where the trees were sprayed some four weeks before I took this picture, and if you were near enough to examine it closely, you could still see some of the deposit

on the trees. As you see, the foliage is in fine condition; it is not harmed in any way.

No wonder that this adjoining estate was "For Sale"; there was not a green thing left on any of the trees. The other day I went by this place and found that they had cut all these trees down.

Many of you may have wondered what these curious burlap petticoats were which you have seen on the trees when you have gone out through a district where there were gypsy moths. I used to think that, in using these burlaps, all one had to do was to put the material around the tree and in some mysterious way it kept the caterpillars from crawling up; but there is considerable work necessary in connection with the use of the burlap. The cloth comes in strips about eight or ten inches wide. You put a piece around the tree and tie it on, then pull the top fold down over the string, and it forms a very excellent hiding place during the daytime for the gypsy caterpillars. The caterpillars feed almost entirely by night. As soon as the sun goes down they crawl up in the trees and get out on the foliage and begin to eat. As the sun rises in the morning they come down and seek the shade. If it is a cloudy day and warm they will sometimes stay up in the tree and eat during the morning, but they generally come down soon after sunrise. When there are burlaps on the tree many of the caterpillars will crawl under them, and here they can be killed. I have been told—and my own experience bears it out—that if these burlaps are well tended, you will get nearly ninety per cent of the caterpillars in the tree. Of course, they will not all come under it the first morning, because many will hide beneath the limbs, but eventually, if the burlaps are tended and turned up each day and the caterpillars killed, you will get about all there are in the tree. It is necessary to put these burlaps above the "Tanglefoot," should there be any on the tree, otherwise the caterpillars cannot crawl down to hide under it.

Now, we will lift up the burlap and you will see under-

neath it lots of caterpillars. They can be exterminated if their numbers are not very large, by cutting them with a knife. It is not a very pleasant task. If they are present in large numbers, it is a long operation to cut each one individually with a knife. Under these circumstances, wire brushes should be used for extermination, made with stiff wire bristles; when one of these bristles goes through a caterpillar it may not kill it or prevent it from crawling away, but it will not transform and become a moth and lay any eggs. It is important to attend to these burlaps. They should be looked at every day or every other day at the longest. They should be taken off in the fall and not left on the tree. If you leave them they will invite other insects, notably some of the borers which puncture the bark and kill the tree. It is no economy to try and use these bands a second year.

This burlap was left undisturbed for five days and then turned up, and here is what I found,—hundreds of caterpillars ready to transform into pupae. Here we see a full grown gypsy moth, and, by the way, the moth, in the case of both of these insect pests, does no damage beyond laying its eggs and preparing for future generations. They do no eating, neither the brown-tail moth nor the gypsy moth. It is the caterpillar in both cases that strips the trees. The moth above is a female. Remember, the female moth does not fly, and it is the female which has this characteristic cream yellow color. We see here the male moth dark brown in color, which flies about very nicely both by day and by night during the month of July.

Now, we will take up the brown-tail moths and caterpillars. The first thing we notice in regard to brown-tail moths is that in the latter part of August we see the foliage beginning to turn brown, as though it had been struck by an early frost. The eggs have been laid in the latter part of June or July, and after the little caterpillars are hatched they begin to eat the outer skin, or epidermis, of the leaves. They soon gather a few of the leaves into nests and bind

them together with silken threads which they spin. We do not notice these nests at this time of the year, but they are there, and later on when the frosts come and the other leaves have fallen, they stand out conspicuously.

We will examine one of these nests a little closer. Inside of the clusters of leaves are numerous little galleries or rooms, and in those rooms are the little brown-tail caterpillars. Here they stay all winter as caterpillars,—not as eggs, as in the case of the gypsies. There may be several hundred little caterpillars in one of these nests of leaves. You see them in the top of the trees where they are tied on to the twigs with silken threads. Here is the old egg cluster which was laid during the previous summer. Of course, there is nothing in the egg cluster now; the caterpillars are all inside of the bunch of leaves. No matter how cold it is there they will stay all winter long as caterpillars. If you pull one of the nests to pieces, you will find the caterpillars apparently frozen stiff, but if you take them into the house they will thaw out and begin to crawl. No matter how much snow there is or how cold it is, they seem to be able to survive.

This picture shows the little brown-tail caterpillars as they first come out in the spring. This photograph was taken on the 9th of April last year. When they come out at this time, they are a little smaller than when they went into the nests in the fall, owing to the fact that they have had a long winter's fast and have had nothing whatever to eat. Even at this tender age, if you rub them on your wrist or on any place where the skin is soft and tender, you will get the characteristic brown-tail rash.

The brown-tail caterpillar grows by moulting, just as the gypsy caterpillar does, but it not so large when it is full grown,—about an inch and a half or two inches long. Quite characteristic are these two orange red spots down near the tail and this double row of white spots, one row on each side of the body. The brown-tail caterpillars prefer deciduous

trees, although I have been told that they have been eating the leaves of pine trees; but that is rather rare.

We will look at the hairs of this caterpillar, for it is the hairs that cause the brown-tail rash. Many people have an idea that the rash is caused by the bite of the insect, but that it not so; it is simply by the contact with our skin of the hairs which come from the caterpillar and moth. You don't have to touch the caterpillar to get the characteristic poisoning, for the hairs are frequently blown about with the wind. In this way they often get on to our clothing as it is hung out on the line. These litle barbs work into the flesh and we get the characteristic rash. There are other hairs on the caterpillar which have finer barbs, but I will speak of those later. These hairs are highly magnified, of course.

An excellent remedy for the brown-tail rash is bicarbonate of soda. Take a little soda and put a few drops of water with it and rub the paste thus formed on the part that is affected, and generally within ten minutes the irritation will go away, and usually within an hour the rash or the welt will disappear. Many other things can be used, but I have found it to be the best thing in my own case. Cooking soda will answer if you cannot get the bicarbonate.

Here we have the pupa or chrysalis of the brown-tail moth, and almost invariably you will find them on the leaves on the top of the trees. Sometimes when the foliage has been eaten off the trees, the caterpillars will transform on the leaves of the shrubbery. At this stage, the pupa stage, they are very poisonous, owing to the fact that the empty caterpillar skins from which the pupae have come are blown about in the air. Sometimes it happens that there are no leaves on the shrubs or on the trees, because they have been eaten off either by the brown-tail or by the gypsy caterpillars, and in this case we may find the pupae upon fences or the side of buildings. This particular house was almost covered with them. The caterpillars were crawling everywhere, and everywhere you found the pupae. This house

was situated in a beautiful location, on the top of a hill not many miles from Boston. I saw the man who was living here. He had been a resident of Boston for some years and wanted to go out into the country for the summer. He found this house offered at a surprisingly low rent, and he could not understand how he could get such a beautiful place, with a fine oak grove surrounding it, at such a low figure. But about the first of June he found out why his rent was so low. The day that I talked with him was the Fourth of July, and and he was not celebrating the day with his accustomed vigor. He was sitting outside the house in a very dejected state of mind. His wife was ill in bed with the brown-tail rash, and one of his children had one eye closed and could scarcely see out of the other. He would have been glad to sub-let at a much lower rate than he paid. On the ground around the walls of his house was a pile of dead caterpillars two or three inches deep. At the foot of all the trees surrounding the house there was the same thing,—hundreds and thousands of dead caterpillars. The place was offensive not only to the eye but to the nose. It fairly reeked with dead caterpillars. You or I would not have cared very much to live in that locality. Adjoining him was a park of eight or ten acres where there were many fine oak trees, and they literally carried the dead caterpillars out of that park in wheelbarrow loads.

One of his neighbors was a little more ingenious and lived in more ease and comfort. He put a band of "Tanglefoot" all the way around his house, across the front steps, up the sides and clear around the building and in a a measure was well protected.

This is the brown-tail moth, and you can see why it is so named. The female has this beautiful brownish tuft of hairs at the end of the tail. The male moth looks almost the same as the female, in size and shape, but it lacks the tuft of brown hairs. Now, I have found in my experience that the hairs of the moth are to be dreaded just as much as the hairs

of the caterpillar, for with me they seem to be just as poisonous. One night I was out around the electric lights catching some of these brown-tail moths, and I captured one individual in the back of my neck. That evening when I retired I counted twenty-seven distinct and separate welts as a result, so it was brought quite forcibly to my mind that the moth has something to do with the rash.

The brown-tail moth when it deposits its eggs takes the hair from its tuft on the tail and covers the eggs over with it. Here you see a moth in the act of spinning the web of hair in which is mixed many of its eggs. This is not the normal way in which the insect lays its eggs. This particular moth I had endeavored to kill. I had put benzine upon it and, supposing it was dead, had laid it down upon a box when suddenly it began to lay its eggs. The operation was very interesting to watch. With its two little ovipositors situated near the end of the tail, it pulled out the golden brown hairs which readily adhered to the eggs which are covered with a sticky gelatinous substance when they are laid. You can see some of the eggs here mixed in with the hair. From this mass of hair with some very fine forceps I picked out a little tuft, rubbed some of it on my wrist and got the characteristic brown-tail rash; and some of the hairs I put under the microscope and got the photograph which you now see upon the screen. These hairs are much finer barbed than most of those which are upon the caterpillar, although the caterpillar itself does have hairs which very much resemble and may be identical with these. They are called the nettling hairs.

Here we see the moths laying their eggs in their normal way, which takes place in the latter part of June or early in July. We seldom see the egg clusters because of the fact that they are usually up in the top of the trees. The egg cluster is not as large as that of the gypsy moth, and is of a different color, reddish brown. They are only a few weeks in hatching, and they do not last over the winter as in the case of the egg clusters of the gypsy moth.

This picture shows a mass of brown-tail caterpillars vainly trying to get up over the "Tanglefoot." The winter before last I went over my place very thoroughly and my men went over it afterwards, and then I went over it again, and we thought we had gotten rid of every brown-tail nest, but there was one tree that somehow we must have missed, for the following spring it was filled with caterpillars that stripped off nearly all the foliage before they were discovered. I had a man go up into the tree with a big mallet and strike the limbs, and the caterpillars came down on to the ground like a shower of nuts after the first frost in the fall. Full-grown caterpillars, both brown-tail and gypsy, can be knocked off in this way, but if you strike the limbs of the tree when the caterpillars are small, they will merely spin down on their threads and hang there as if they were laughing at you, and after the pounding is over they will climb back up into the tree. When they are big, however, the little thread will break and they will fall to the ground. I took this photograph two or three hours after the tree had been shaken and the caterpillars are now trying to crawl up over the "Tanglefoot," and they can't do it.

Many of you saw during the latter part of last June the flights of the brown-tail moths, particularly around the arc lights at night. They do not seem to be attracted to the incandescents, but around the arc lights the air was white with flying moths and in some cases the electric light poles were coated white with them. If you are at all observant, you will have noticed on the ground around these electric lights a great many toads jumping about and gobbling up the moths. I don't know what kind of a digestion these toads have, but it is evident that it must be very good, for they eat a great many of these moths, brown hairs and all. This photograph was taken late at night, and this man with the moths all over him is immune from the brown-tail rash, otherwise he could not have been in the electric light business.

In Belmont advantage was taken of the fact that these

moths were attracted by electric lights after dark, and the Belmont Society for the Suppression of Insect Pests made some traps which were set around the arc lights. They built the traps of telegraph wires, making a skeleton frame and covering it over with cloth, and over the cloth they smeared "Tanglefoot" or pinned on "Tanglefoot" fly-paper. I had the pleasure of counting two thousand dead brown-tail moths in this one trap on the morning after its first night's exposure. Twenty electric lights were eventually fitted up. Later on we found it was more economical not to coat the cloth with "Tanglefoot," but simply to take the "Tanglefoot" fly-paper and pin it on the sides and over the bottom of the trap, and then remove the fly-papers as they got full. Otherwise, in using the "Tanglefoot" which comes in bulk, the cloth would get so thickly covered that it was very hard to scrape off the moths and re-coat it.

The thing to do in regard to the brown-tail nests—although it is too late in the season to do it now—is to cut them off from the tips of the branches and burn them up. This work should be done just as soon as the foliage drops in the fall. Of course, it can be done any time before the last of March, but now the little caterpillars are out on the trees. It is important in this work to pick up every one of these nests after they have been cut from the trees and not let them stay on the ground. They must be burned up, and it is better to burn them in a furnace than in a bonfire, because in a bonfire you are pretty sure to leave some of them around the edges of the fire.

I shall now run rapidly through a series of slides showing the life history of the gypsy caterpillar and moth. I have taken the gypsy obviously for the reason that it is much more comfortable to experiment with them than with the brown-tail. If I had undertaken to make photographs of the brown-tail moth, I think I would have spent nearly all my time in scratching and not in taking photographs.

After the caterpillars are full grown they hang by a few

silken threads spun from the tail and they begin to shorten and thicken up, as you see here, and assume this position. Pretty soon they twitch a little, and each time they twitch, some of the skin is pulled down towards the tail, and the body gets thicker and shorter. With each twitch more of the skin is pushed down towards the tail, until by and by it splits just back of the head and the pupa begins to come forth. At first it is of a delicate pinkish color, as you see it here. Each time it twitches, the pupa comes further and further out, until by and by it is entirely free. These peculiar flaps which you see here are to be later on its wings, and these are to be the feelers or antennae, and these are what are to be later on the moths' legs. Here is the empty caterpillar skin left hanging behind on the tree. Now, in a few minutes, it quickly loses its pinkish color and begins to turn brown. Very often it turns a much darker brown than this, a chocolate brown and even black. Here it hangs for eight, ten or fourteen days, varying with the temperature of the weather, until the time arrives when the moth is to come forth. Then it breaks away at the head and we see the golden yellowish color of the hairs upon the head of the moth. This process all takes place in a very few minutes, varying from fifteen or twenty minutes to half an hour, from the time the chrysalis breaks until the moth has come out and its wings have grown and it is ready to lay its eggs. Further and further the moth crawls out, and now we begin to see its wings. In a few minutes the wings are further seen, and they already have begun to grow. Now the moth is all out, and the empty pupa skin is left behind. The insect turns around and begins to crawl up the tree or fence, wherever it may be. It is an ugly and misshapen creature at this stage, with a tremendously large body and small, shrivelled wings, but they grow very rapidly. The body seems to shrink and the liquids from it flow out to the wings, and you can actually see them grow before your eyes.

Finally, after the wings are full grown, very gently the moth begins to raise them over its back. In this picture you

can quite easily imagine a lady in a beautiful ermine cloak. Here is the face, here is a curious hat adorned with numerous stick pins, with the folds of the cloak hanging down on either side. Finally the wings are held directly out behind and the insect very slowly moves its body back and forth, as it drys them. It does not flap its wings, as some other moths and butterflies do, but it very slowly moves its body, and then, suddenly, after a few minutes, it brings its wings down to its side, as you see here. This particular moth shows a curious thing. We see here a very ugly and grotesque face on its back, and this photograph has not been retouched at all. Here is the chin, the mouth, the eyes and ears, a devilish sort of a face, that ought to be on every gypsy moth, though I am sorry to say it is not. By a strange chance, these pictures are very beautiful, and it seems rather queer that an insect which can do so much damage should have any beauty about it.

Within a few hours, and sometimes minutes, the female has mated and egg-laying is begun. This sometimes takes twenty-four hours or even longer. Slowly the eggs are deposited and covered with hairs taken from the body of the moth. Then the insect dies close by the eggs which it has laid, and future generations are left to vex and annoy us.

Finally, I want to call your attention to the differences between these two insect pests in their different stages. Here, on this side of the picture, we have an egg cluster of the gypsy moth, and on the other side a leaf nest of the brown-tail moth. Both of these we see during the winter months. These egg clusters of the gypsy moth are covered with yellowish hair, and no matter how cold it is the caterpillars will hatch out in the spring. These nests of the brown-tails we see in the tops of the trees ; they are full of little caterpillars, and in the spring they will crawl out on the first warm days. In the next pictures we see one full grown caterpillar. On this side the gypsy, with its characteristic double row of red and blue spots, six red and five blue,—and you must remember

that it is the caterpillar of both the insects which does the damage by eating the foliage of the trees,—and here we have the brown-tail caterpillar with its two characteristic orange red spots near its tail and a row of white spots on either side. It is the brown-tail and not the gypsy that causes the rash.

Finally, we have the moths,—on this side the gypsy moths, these two lower ones being females, and here are the males.

Remember that the gypsy female moth does not fly, though the brown-tail does. Here we have the brown-tail moth, below the female with its characteristic golden-brown tail, and these two are males.

Now, I haven't said a word about parasites, because I don't know very much about this part of the subject, and the gentleman who is to follow me will tell you what has been done in this direction. I think it is up to each and every one of us to do all we can to help Mr. Kirtland, who has charge of the work of suppressing these pests. He has got a hard row to hoe, and he needs the encouragement and help of every intelligent man, woman and child in this state. I thank you very much for your kind attention.

(Applause.)

THE CHAIRMAN: The Association, by a great piece of good fortune, has present this afternoon the State director of this business, and Mr. Kirkland has very kindly volunteered to speak to the Association. I take pleasure in introducing him to you.

ADDRESS OF SUPT. A. H. KIRKLAND.

State Superintendent for Suppressing the Gypsy and Brown-Tail Moths.

Mr. President, and members of the Association, I find myself in about the predicament of the boy whose father was a lecturer, a monologist. The old man was practising up his monologue one day, and the boy heard him and said, "Pa, I want you to take me to the show." The father said, "All

right, my son, next week I am going to give my monologue at such and such a theatre, and I will take you." "Pshaw!" said the boy, "I want to go to a real show." You people have had the "real show" and I am fearful that what I may have to add will not be in the nature of any important contribution. Professor Underwood, with the aid of his slides, has very ably treated the biology of the moths and the principal remedies. I am going to speak now of two or three other features, some of the larger features, of the work.

I want to show you first, as a matter of interest, the place where Professor Trouvelot lived in Medford at the time the gypsy moth escaped from his care. He was a poor man, and lived in this house surrounded by brush land. The gypsy moth was brought over here, as you probably know, with the idea of crossing it with the silkworm and thus producing a hybrid moth which would spin silk and yet which would not be subject to the diseases of the silkworm. The moths got away from him and escaped into this brush land and there multiplied slowly until they reached a point where the citizens of Medford could not take care of them, and the city had to appeal to the state. The state work of suppression was carried on from 1889 and 1890 up to the winter of 1900, at which time the moths were under control. Then the work was dropped for a time but was taken up again this last summer. I ought to say that at the time the gypsy moth escaped, Professor Trouvelot understood the importance of the affair and gave due notice of it. He notified the Harvard College authorities, he notified the people at Washington, he notified Professor Riley of Missouri, the leading entomologist of the country at that time, and did all he could to have the importance of the matter put on record. A couple of hundred dollars would have bought up the scrub land around his house at that time and I presume two thousand dollars would have bought the house also, and the whole business could have been burned up and the gypsy moth completely wiped out. But no one appreciated the danger. It is another case of hind-sight rather fore-sight.

This picture illustrates the creosoting process which Professor Underwood spoke about. The creosote is carried in tubs or pails, and the nests are soaked by means of a brush. We find in street work and in woodland work, where the moths are thick and the nests are up near the top of the trees, that it is a very advantageous scheme to take a pole and lash a brush at the end of the pole, and by means of this device a man can reach the under surface of the limbs and eradicate the nests in that way. That method is perhaps a cruder one than using a short brush, but it is effective with probably ninety-five per cent. of the nests.

The process of burlapping on a large scale is shown here. The rows of burlap are carried in a barrow, with a string through the centre of each row,—or very often the burlap comes as it is cut out of the bale, and thrown over the man's shoulder—and he puts a band around the tree, cuts it off, sticks in his knife, ties it and turns it down. This is all done very quickly. To one of our towns where they have shown a great deal of interest in putting on burlap this summer, I sent an inspector and he found that they were sending a man around with a string to measure each tree and then come back and measure his burlap, cut it off and take it back to the tree to tie it on. Our inspector went there and burlapped twenty-five trees in the manner I have described while this man was burlapping five by that method. That was an eye-opener to those people.

This picture shows the work of spraying trees, more particularly orchards and shade trees where they are not too tall. Many of our streets have been planted during the last ten years with Norway maples, and those trees are not so tall but that they can be sprayed from an elevated tower like this. In that way we can push the work very rapidly and very cheaply. This year there has been gotten up a rig—I am sorry I have not a slide of it—which is practically the same as is used by the electric linemen. On either side of the tower is lashed a 40-foot extension ladder or a 30-foot extension

ladder, as the case may be, and those ladders can be run up about 15 feet above the tower. Then we lay a "boatswain's chair" or a piece of plank with four rings to hold it to the tops of the ladders, and a man can climb up to this platform and get up about forty feet in the air, and he can spray quite tall trees.

This picture shows the largest spraying device, I believe, in New England,—the largest one I have ever seen and I think it is the largest tower outfit in the country. It is the one used by the Boston Park Department and is very effective. It is mounted on a substantial wagon, having a gasolene engine with a direct connection with the pump, and by means of it one can get as high as 200 pounds pressure to the square inch. With this apparatus you can use a straight-away nozzle, and the pressure is so intense that the stream bursts into a fine spray. In this way you can spray tall trees fairly well, but those straight-away nozzles use up a tremendous amount of poison, although they make for economy in the way of labor.

This picture shows the outfit used by the Metropolitan Park Commission. One man is attending to the lower part of the tree, and the other man is working with a high pressure nozzle and reaches the top of the tree. As I say, this method wastes a good deal of the spraying material, but where the caterpillars are very thick and where time is short, as it often is in the spraying season,—for we are limited to fair days and cannot spray on rainy days,—we can do good work with a rig like that. It is a simple thing to run a ladder up on each side of this car and put a little platform on top of the ladders on which a man can stand at a relatively high elevation from the ground.

In brush land and scrub land, and very often in wood land, many nests remain on the ground, and it has been practically impossible for us, with the funds at our disposal, to go in and doctor every nest, turn over stone walls, etc. In other words, we have to apply wholesale methods. In such places we go

in and clear the trees of the nests, after cutting out all the dead trees, the crowded trees and brush,—adopting good sensible forestry practice,—and let the ground go. Then in the summer time as soon as the eggs hatch, an oil flame is applied to the ground and in that way we burn up ninety-five per cent. of the caterpillars. I had complaint only yesterday from Swampscott. A man came into the office, a very intelligent man, and said, "Your people have cut over about one hundred acres of scrub pasture land down there and have left the brush in piles. Why haven't they burnt it up?" I told him we knew all about it. That particular section was the worst infected spot in Swampscott. Last winter, in spare time, it was cut over and the brush left there. In about ten days from now every nest will hatch out, and every spear of grass, every bit of dead brush, everything on the ground will be covered with these tiny caterpillars. Then, on a suitable day, when the wind is not too high, we can run a brush fire through all that whole business and for a few dollars we can wipe out the moths over one hundred acres in this badly infested territory.

This picture shows the extensive work that is necessary to put woodland and scrub land into condition for burlapping or for further treatment. We go, for example, into a white birch swamp, where the men cannot work to advantage and where they can hardly get in themselves in some cases, and there we thin out the trees, leaving single ones standing twenty or forty feet apart (this depending on the size), and taking out all dead and worthless stuff. Then the remaining trees will attract the caterpillars, because they furnish all the food that is left. When these trees are sprayed and burlapped, we get the caterpillars on that entire area and in this way we wipe them out.

Professor Underwood referred to the killing of trees by the gypsy moth, and this really is the most serious phase of the whole question, so far as this insect is concerned. You know our deciduous trees have considerable recuperative

power. An apple tree or an oak tree will stand stripping two or thre years in succession before it succumbs. I have seen an oak grove in Malden—a clump of oaks of perhaps eighty years' growth—killed out absolutely by three successive strippings by the gypsy moths. Now, the conifers—the pines, hemlocks and spruces—are not so gifted with recuperative power. One single thorough stripping will kill them. This clump of white pines at Malden on the Melrose line, was stripped in 1904 by the gypsy caterpillars for the first time,—this is a matter of my personal knowedge,—and last June when this photograph was taken, these pines were dead, as you see here, and the bark even had begun to pel off. When Deacon Converse, the Malden philanthropist, gave the two cities of Malden and Melrose the Pine Banks Park, it was a beautiful place, containing some of the largest pines anywhere around Boston. Now the men in charge of the park later did not fight the gypsy moth effectively, and the result was that last year they found that they had got to go to work in a big way. They did the best they could and spent several thousand dollars there—a very large sum for such a small area—but could not save those beautiful pines. Four hundred choice white pines, in round numbers, are dead and have been taken out. "Pine Banks Park" is a misnomer. It might be called "Barren Banks Park," or "Rock Park." There are some pines left which they are working heroically to save, if possible, but the beautiful pine grove has been practically ruined and its beauty destroyed. I went with Governor Bell of Vermont out there when he was down here recently. He wanted to see some of the gypsy moth work, and when he saw this he said: "If this gypsy moth gets up into Vermont, I can see the finish of the summer boarder industry." That is, of course, a serious thing.

This little slide does not show much at first glance, but it is one I am particularly proud of and one I am very much interested in, because it shows what a poor hard-working laboring man can do when he really sets out. In this section of

Malden, farther up the street, there live a number of very well-to-do people. The whole territory was swept in 1905 by the gypsy moth plague. The moths simply riddled everything. Now, this man treated his gypsy moth nests around his house with creosote, he burlapped his trees, he went to the expense of having his trees sprayed. I don't know what he put into this work, but he is a man working for about a couple of dollars a day, a man of no resources, with a family to support, but he had a love for trees in his heart and he made up his mind he was going to save those trees because he loved them, and he did so. Now, in August, when everything was a barren waste all around him, these oak trees came through in very fair condition and he gave what to my mind was a mighty good object lesson in good citizenship to the people all around him, even to his wealthy neighbors. That shows what a poor man can do. Of course, a man with the resources of General Lawrence of Medford can accomplish a great deal more.

This map, gentlemen, shows the size of the problem which confronts the state superintendent. A year ago the legislature passed a bill—I wasn't here at the time—which had in contemplation the fact that the gypsy moth occurred in an area which included thirty-four cities and towns, and they made an appropriation based on that fact. When I took up the work, the middle of May, of course the first and most logical thing to do was to "take account of stock." The moths had multiplied during five years and they had spread widely. We didn't know what the size of the problem was. I organized a corps of trained men and sent them out to investigate. As fast as a man found one town infested, he went on to the next, until by winter we had located the gypsy moths up to the New Hampshire line, from Salisbury over to Methuen. We also found them in Dracut and Lowell, and as far west as Stowe, Marlboro and Hopkinton. To the south we found them in Stoughton and following the exact border of Plymouth County as far as Lakeville, and then over to Wareham. We

have also found the gypsy moth at Bourne, Yarmouth, Barnstable and Orleans on the Cape, where they were undoubtedly carried by automobiles. Since Quincy has become so badly infested—and Quincy is really the gateway to the South shore—there have been days when the caterpillars simply hung in thousands from the trees, and nothing is more reasonable than to suppose that the automobiles passing under the trees and going rapidly toward the Cape have taken the moths there.

I want to show you here one of the parasite cages. We are working along the line of introducing parasites. We are trying to leave no stone unturned—trying to adopt every method that promises any sort of relief. Of course, the natural thing, the scientific method, is to get the natural enemies of the gypsy moth here and see if our climate will allow them to multiply; because we are fighting the devil with fire, and we want to get the fire as soon and as hot as we can. In Europe Dr. L. O. Howard has organized for us a corps of about fifteen of the best entomologists, all on salaries you might say, engaged in collecting all the natural enemies of the gypsy moth and sending them over here to me. We are preserving this material at Saugus, and shall, as soon as the parasites come out, liberate them in cages like this. In this enclosure there is a badly infested apple tree, and we shall put the parasites on that. This structure was made last summer. It consists of a large frame covered with two thicknesses of wire netting. We have had to keep a watchman there because the average small boy likes to throw stones, and he does not always appreciate the value of a scientific experiment. We shall put the parasites into these cages and give them a fair chance to fight it out with the gypsy moths. When we get a sufficient supply, we shall turn them loose in the woodlands in large numbers, and put out enough to make a fair test so that they may have a chance to mate and become colonized. In Europe the brown-tail moth has many parasites in the web stage. We have nothing of the kind here, at least, we have

never discovered anything of the sort. The European webs of the brown-tail moth contain many tiny parasites that prey on the caterpillars in the web in the fall and again in the spring. When this fact was discovered, we at once ordered the collectors to turn to and get all the brown-tail webs they could find. They sent us over 108,000 of these webs from Europe. We put them in these tight boxes fitted with tubes through which light penetrates into the interior. The parasites emerge from the webs, and flying to the light go in large numbers into the tubes. We then take out a tube, cork it and put in a fresh one, and soon we have another full of parasites. But we have to separate the "sheep" from the "goats." There are very many parasites which are beneficial and there are parasites on parasites which are distinctly harmful. Dr. Titus, one of Dr. Howard's assistants in Washington, is at work sorting out this material and separating the sheep from the goats. We are going to destroy the secondary and harmful parasites and try to get what the bacteriologists would call "a pure culture" of the beneficial parasites and then we shall liberate them to prey upon the brown-tail caterpillars.

This picture shows another type of breeding cage, with plants for the insects to work upon. The next slide shows certain forms of parasitic insects. These are American, but are congeneric and practically similar in appearance to some which we are introducing. The Tachinid flies, which appear much like our common house fly, lay their eggs on the body of a caterpillar. In Europe we find caterpillars with large numbers of these eggs on the outside of their bodies. When the egg hatches, the grub burrows into the interior of the caterpillar, eats up the fluids, destroys the digestive apparatus and cuts the nerve cord. Then the grub comes out and buries itself in the ground and in a little while transforms to a fly such as you see here. The true ichneumon flies do not have to go quite so long a journey. They are armed with a stinger or ovipositor, and in this case the female is the one that does the good instead of the harm, contrary to the habit of the

gypsy moth. She goes to a pupa or sometimes to a large caterpillar which is ready to pupate, and drives the stinger into the body and deposits an egg therein. The egg hatches and the grub destroys the caterpillar very much in the same manner as with the Tachnids.

I want to call your attention here to two or three insects which are often mistaken for the gypsy moth. Here is one which is sent to me perhaps a hundred times every year. It is the spiny elm caterpillar, the common caterpillar of the elm, willow and poplar. It feeds in clusters on the branches of the trees. We find it in June and then another brood in August and September. It has spines instead of hairs and red patches on the sides, but no blue spots. There is no need of confounding it with the gypsy moth caterpillar. It makes a very attractive butterfly, the first butterfly of the summertime, the Vanessa, or mourning-cloak butterfly. The species is distributed throughout the north temperate zone. It occurs all the way across the continent, and has been taken up in British Columbia nearly as far north as Alaska.

Another elm caterpillar, that of the tussock moth, shown here, is a common every-day pest which is often mistaken for the brown-tail caterpillar. Last year in the course of the season we had I don't know how many specimens sent us for brown-tails. If we remember that the tussock moth caterpillar has two pencils of hair pointing forward and one pointing backward and that it has four nice, white brushes on its back, while the brown-tail caterpillar has none of these markings, we need not confound it with the latter.

Here is a common fall caterpillar which last year was very abundant, the Datana caterpillar, which works on the apple, plum and sometimes on the cherry. We do not get these insects until into September or October, very often not until October. If we remember that the gypsy moth caterpillars are practically done feeding about the middle of July or the first of August although there are a few stragglers later, if we remember that they do not occur in large numbers as late as

September and also that they do not feed in clusters on twigs as this fellow does, also that they do not have the habit of sticking up their head or tail and swinging it viciously if disturbed, we can discriminate between the two insects. This caterpillar is common in orchards, especially in cities where the native birds have been driven away by the English sparrow. They can be handled by jarring them off the trees or by spraying. We do not recommend burning although many do burn them off.

Now that the gypsy moth has been so well advertised, people are on the lookout for strange insects. It seems as if every man who finds an insect which is new or strange or startling or gaudily colored or out of the usual run at once thinks he has the gypsy moth, and he boxes it up and sends it to me. This large caterpillar has been sent in repeatedly late in the fall for that of the gypsy moth, although of course it bears no resemblance to it. The moth from this caterpillar is the beautiful Polyphemus. Speaking of this matter, I think that a farmer in western Massachusetts a while ago about "went the limit." I think he was perfectly sincere, because he wrote in a cramped hand, and dried his letter over the lamp. He sent me a bat, thinking it was a gypsy moth.

This, I think, completes the slides. Now, just a word or two about the state work as it is now progressing. Briefly we have found that the gypsy moth occurs in 127 cities and towns. We have now an area, roughly, of 2300 square miles of infested territory as against 359 square miles known to occur when our work started last summer. The problem, in other words, is about six times as large as we thought it was. The moth area now includes about one-quarter of the state. The gypsy moth district embraces about seventy-five per cent. of the taxable valuation of this state. In other words, when we ask people to pay money to fight the gypsy moth, seventy-five per cent. of the money is raised right where the money is spent, and I have been assured time and time again by people in western Massachusetts that they are willing to be taxed for

the other twenty-five per cent. for the sake of being protected. The bill under which we are working contemplates cooperation on the part of the individual citizen, the city or town, and the state. We haven't a very large force of men connected with the state office,—about thirty-five trained men,—and I will say that every man I have hired so far has been a man with a record of experience in this moth work and of an established reputation as a skilled moth man. These men scout the territory, locate the moth colonies, and then, as soon as the town work is organized, work with the town gangs, instruct them in methods of work, and then go in behind the town gang and scout again to see if the work is well done. Then we shift the inspectors from time to time so as to follow up each man's work. Last summer it was a pretty regular thing for many of the towns to appoint as their officers in this work men who had no experience, but we are getting to a higher state of efficiency every day. We are improving the work and getting things now so that when an inspector goes into a town, instead of reporting five hundred or a thousand nests overlooked by the town workmen, as in the past, if he reports fifty or sixty, we go down there and see what is the matter.

The city or town puts up the money to finance the work. We tell them how to spend their appropriation and call on them to appoint some local officer or board who shall be responsible for the work. If a city where the valuation is twelve and one-half million dollars or more spends five thousand dollars a year in this work, the state will reimburse it fifty per cent. of all money spent beyond that amount. In other words, if the city of Medford spends, say, $15,000, the state will give it back at the end of the year, if the work is satisfactory, half of the extra $10,000 over the first $5,000. In other words, the state will reimburse the city of Medford $5,000. The cities and towns having a valuation between twelve and one half millions dollars and above six million dollars spend one-twenty-fifth of one percent of their valuation, and above that

the state will reimburse them eighty per cent. Then, the poorer country towns,—and many of them are among our worst infested districts,—having a valuation of less than six million dollars, spend one-twenty-fifth of one per cent. of their valuation, and then the state will reimburse them one hundred per cent. of all expenditure above that amount,—that is, the state gives them back all the excess expenditure. In other words, the purpose of the law is to give the least help to those cities and towns best able to help themselves and to give the most help, relatively speaking, to the poorer country towns.

But the thing does not end with the city or town. Every citizen of an infested district is notified in the fall of the year that he must clean up his property. Many of you have received these notices. The city or town fixes a date when the property shall be cleared, and if a man does not do the work by that time, the city or town has the right to enter—and so far as our funds permit it, does enter—upon that man's land and destroys the gypsy or brown-tail moths, and the cost of the work up to one-half of one per cent. of the valuation of the property is put in the tax bill as a special tax, just as in the case of the street watering tax. In other words, we touch the pocket nerve of the individual citizen. The result will be, in my judgment, that as soon as a man finds that he is going to be taxed for this work, he will familiarize himself with the moths and with the remedies for them, and he will clear his trees, cut down the worthless ones, and have only those he can take care of. The law, you see, gives us a good opportunity to get after the non-resident property owner. Hitherto this has been the obstacle right along. To give you an illustration. A man living in a western city owned real estate in Winchester. In 1905 his neighbors cleared their trees, but this man wouldn't do anything, although letters were sent to him. This year his trees are worse infested than ever. The town notified him to clear them and he refused. The result was that a gang went in there, cut down about two-thirds of

his trees and cleared the rest, while the town has charged him up to the limit for the work. In other words, we spent his liability. Now, I suspect that next year he is going to look at this thing in a very different way. It has been the great misfortune of the work in the past that no matter how well you or I might clear our trees, if our neighbor chose to neglect his trees there was no way to get at him. Now, we have a law that is sufficient, and we do not propose to allow a man to maintain a nuisance to the detriment of his neighbors.

Just a word as to the outlook for controlling the moths. We have been obliged so far to give our particular attention to cleaning the streets, thus stopping the scattering of the caterpillars by teams and automobiles—to prevent their being caried farther into the state. That work is practicaly done. We have ninety-five per cent. of the streets in the gypsy moth district clear. We have practically all the settled residential streets clear. In other words, we have got the brown-tail and the gypsy moths where they will not readily poison people next year in these sections. We shall now give our attention to the wood land and carry on the work year by year until we can wipe out the large woodland colonies of moths, which is simply a question of funds and of men and of cooperation. Without cooperation we shall probably fail. But if we can get cooperation all along the line, if the state superintendent does his duty, if every city and town official will come up to the mark and do his duty, if every individual citizen will take a live interest in the work and do his part, I am sure that in a very short time, within a few years relatively speaking, we shall have the condition of the moth territory back where it was in 1899, and then the work can be left with the cities and towns for each of them to handle its own moth problem.

I have brought here a few bulletins which we have issued upon the subject, and I shall be glad to have you take them. If the supply is not sufficient, write me a line at No. 6 Beacon Street, and I will mail to you any number you may wish to use. I thank you for your attention.

(Applause.)

THE CHAIRMAN: Mr. Kirkland has given us a lot of useful lessons as to what public health officers can do. I wish the supreme health officer of the Commonwealth had anything like the power which Mr. Kirkland has, and I wish also that he might use it as wisely.

DR. DURGIN: I move a vote of thanks to Mr. Underwood and Mr. Kirkland for their excellent and instructive addresses.

THE CHAIRMAN: It is moved and seconded that a vote of thanks be extended to Mr. Underwood and Mr. Kirkland for their addresses. All those in favor of this will signify it by saying "Aye."

(Response, "Aye.")

THE CHAIRMAN: Contrary minded, no. It is a very unanimous vote. Is there any other business for the Association at this time? If not, it is moved that we now adjourn. If that be your pleasure, you will signify it by saying "Aye."

(Response, "Aye.")

THE CHAIRMAN: Contrary minded, no. The meeting is adjourned.

MUNICIPAL SANITATION.

By Charles V. Chapin, M. D.,

Superintendent of Health, Providence, R. I.

COLLECTION OF GARBAGE. All health officers recognize the extravagance and inefficiency of garbage collection by private scavengers who receive their compensation from the householder. Nevertheless, even in some large towns this method is still followed, and it is interesting to note just how

expensive and inefficient it is. Thus in Grand Rapids* householders pay twenty-five cents per month for the removal of garbage, but not more than one quarter of the population avail themselves of the privilege. In Montclair, N. J.,† a town of 16,000 inhabitants, the removal of small cans of garbage costs from six dollars to nine dollars per year, and of large cans twelve dollars. The aggregate cost is about $12,000 a year, although only about one-third of the houses are served. These figures may be profitably compared with the cost of efficient municipal collection, which in Boston is twenty cents per capita; in Lynn, eighteen cents; in Brockton, seventeen cents; in Worcester, fourteen cents; and in Lawrence, ten cents.‡

DISCHARGE OF DIPHTHERIA PATIENTS FROM HOSPITALS. One of the topics touched upon in the very valuable report of Dr. A. G. R. Cameron on "Return Cases of Scarlet Fever and Diphtheria"¶ is the criteria for discharge of patients. It is surprising to learn that at one London hospital no culture whatever is taken from the patient before discharge; in two others none have been taken until very recently; at three others cultures are only taken when the mucous membrane of throat or nose appears abnormal, and in the four other hospitals only one throat negative is required for release. The average period of detention in the hospital of the 6,866 recovered cases considered by the report was 57.5 days. Of these, 87, or 1.2 per cent. carried infection to their homes after discharge. In Providence§ patients have always been discharged on two throat and nose negatives, except for a few patients discharged on one throat negative at the time cultures first came into use. The average period of detention in the hospital of 832 recovered cases since 1896 has been 21.2 days. Of the discharged patients, 1.3 per cent. carried infection to their homes, a result substantially

*Report of the Board of Health for Year Ending April 18, 1904, p. 24.
†Report of the Board of Health, 1904, p. 27.
‡Municipal Sanitation, Chapin, p. 701.
¶Report to Metropolitan Asylums Board, London, 1901-2, pp. 59-72.
§Report of the Superintendent of Health, 1905.

as good as that obtained in London where the period of detention is nearly three times as long.

A DISINFECTION EXPERIMENT. For reasons set forth in a paper read at the Providence Medical Association† it was determined to abandon official disinfection after diphtheria unless two throat and nose negatives should be obtained from each member of the infected family. The cultures were to be entirely voluntary as far as the family was concerned, and in their absence the warning sign was to be removed ten days after the disappearance of the membrane. As may be inagined, very few disinfections were done after the rule went into effect about March 1, 1905. During the year there were eighty-seven families in which disinfection was done, in two of which, or 2.30 per cent., recurrence of the disease took place within two months. In 258 families where there was no disinfection, there was recurrence in 1.55 per cent. It is also to be noted that the total number of cases in the city in 1905 was 562, or 218 less than in the preceding year, and less in proportion to the population than in any year since 1900.

MOSQUITO LEGISLATION. The State of New Jersey had previously made a considerable grant for the study of the mosquito problem and has now provided by law for the abatement of the nuisance.‡ The sum of $10,000 was appropriated by the State to aid towns in the work of abatement, but only $500 can be expended in one town, and the town must in each case appropriate seventy-five per cent. of the total sum required. Provision is made for the abatement of the nuisance when the breeding-place is outside of the township affected and for the co-operation of towns. For the purpose of investigation $5,000 was appropriated. Both appropriations are to cover two years. The agricultural experiment station has charge of the administration of the law.

†Journal of the Providence Medical Association, 1905, page 109.
‡New Jersey Acts of 1905, Chapter 80, 30 March.

SANITARY ENGINEERING NOTES.

By Robert Spurr Weston, Assoc. M. Am. Soc. C. E.

PROTECTION OF INDIANA WATER SUPPLIES.* Brossman suggests the following water protection measures for the State of Indiana:

1. The passage of proper pollution laws covering municipal and industrial waste.

2. Appoint health boards or health officers in all towns not having the same.

3. Pursue a systematic investigation of the waters of the state and their sources of pollution, by the appointment of assistants under the direction of the State Board of Health, having tests made at regular intervals, as outlined above.

4. Empower the State Board of Health to take up the investigation of trades waste disposal, when such wastes endanger the public health.

5. Have the State Board of Health approve all plans for water supply and sewage disposal, and any industrial plants in which the waste is to be discharged into streams used as water supplies.

6. Give the State Board of Health the means of pursuing such investigations as have been outlined, and an engineer as a consulting member.

REPORT OF NEW YORK STATE WATER SUPPLY COMMISSION.† The report, including the report of the Chief Engineer, Mr. Myron S. Falk, was presented to the New York Legislature Feb. 1st. It discusses at length the question of water rights, land damages, municipal co-operation and state supervision of supplies. The engineer comments adversely upon the proposition to furnish a water supply to the state as a whole, and recommends for the supervision of the supplies of the state an adaptation of a certified milk system, the commission certifying water supplies much

*Charles Brossman, Jr., Indiana Engineering Society, Jan. 20, 1906.
†"Engineering News," Feb. 8, 1906, page 147.

as the pediatric societies certify pure milk. The commission would hope to give the facts and let public sentiment do the rest. It does not think it advisable for such a commission to have final power over the water supplies of the state.

SEWAGE DISPOSAL IN ENGLAND.‡ The trend in England is toward the installation of trickling or sprinkling filters. They were proposed in nine-tenths of the schemes which came before the Local Government Board in 1905.

It is also interesting to note than on some English sewage farms peppermint has proved a successful crop, especially at Sutton (Surrey), where a profit of $700 was made last year.

SANITARY CONDITIONS IN THE NEW YORK SUB-WAY.¶ A recent report by Dr. G. A. Soper states that the air of the Sub-way is changed quite rapidly; that the percentage of carbon dioxide does not vary greatly from that of the street air; that the disagreeable features are due to the heat produced by the electric power and the smell of the lubricating oil, and that the movement of trains causes more movement of air than certain centrifugal fans which have been used experimentally. It is recommended that ventilators be placed between stations, which ventilators will open to let out sub-way air but will close against street air. The latter is best admitted at the stations. Dr. Soper condemns the broken stone ballast at the stations on account of the filth it collects. Much of the odor and dirt is due to the carelessness of the attendants in charge of the toilet rooms.

RELATION OF SEDIMENTATION AND ACID WASTES TO THE POTABILITY OF THE LOWER MONONGAHELA RIVER.* In 1905 the author investigated water supply conditions on the Monongahela River, which receives the sewage of nearly 200,000 people in the 80 miles between Greensboro and Pittsburg. This unsuitable water is used by the various towns along the stream and is

‡"Engineering News," Feb. 15, 1906, page 178.
¶"Engineering News," March 8, 1906.
*S. J. Lewis, "Engineering News," March 15, 1906, page 293.

considered to be safe and wholesome. This belief springs from two features peculiar to the locality:

1. The stream is for a large part of the year so completely without current that many think the sedimentation thus afforded will rid the water of all impurities.

2. It is thought that the large amount of acid industrial wastes exercises a powerful germicidal effect on the disease bacteria that may be in the water.

The author makes a very careful study of the amount of sedimentation and finds that the actual detention of the water in the river is very low, especially when the stream is at its maximum flow. This affects the typhoid fever death rate. For example, the sewage of Charleroi, with a population of 7,000, enters the river only a few miles above Monessen. The typhoid fever death rate at Monessen is from six to thirty-three per cent. of the total mortality, as against less than one per cent. in many American cities having unpolluted water supplies. Most of the typhoid has been connected with the use of the water supply. Worse conditions prevail at McKeesport where the typhoid fever mortality has gradually increased during the the last ten years. Again, Pittsburg has a typhoid fever death rate of over 100 per 100,000 and as high as 144 per 100,000. It would seem, therefore, that the slight amount of detention of the sewage in the river during the flood season would be useless on account of the scouring, and that during the rest of the year there is so little water in proportion to the amount of sewage discharged that the water cannot be called safe.

The addition of acid iron waste and free sulphuric acid is supposed to cause precipitation of iron and lime and remove the bacteria by coagulation and sedimentation as well as by its direct bactericidal effect. The amount of free acid is small and at times does not exist. Therefore the amount of precipitate is very variable and at times wanting. Furthermore, the

maximum amount of acid alone would require many hours exposure to kill the bacteria. The author says in his summation: "The mineral acid to benefit the water must act either as a coagulant in the form of sulphate or as a germicide in the form of acid. For the former there is not enough iron; for the latter there is not enough acid."

REPORT OF GARBAGE AND REFUSE COLLECTION AND DISPOSAL AT COLUMBUS, O.

Every reader of engineering literature has been struck with the progressiveness of the City of Columbus during the last three or four years, when after a Fabian policy of many years the City has not only perfected plans for a new sewage disposal plant and water supply system, but has just appropriated $290,000 for a new garbage and refuse plant based upon the report and detailed estimates submitted by Mr. John H. Gregory, Principal Engineer of the Board of Public Service.

The "Engineering News" (March 15, 1906, page 305) states that: "So far as we know, these estimates are the first detailed engineering estimates of the cost of providing the City with a complete plant for the collection and disposal of garbage and rubbish and of the yearly cost of maintaining and operating such a plant, including capital charges."

Antedating Mr. Gregory's report was a report by Mr. Rudolph Hering, who advises the City to collect both garbage and general rubbish and after hauling them to a proper site and mixing them, to dispose of them by cremation. On account of the use of natural gas in Columbus the output of ashes is small. There is no public collection of rubbish at present. About $30,000 a year is paid to public scavengers for the removal of rubbish alone. Night soil is removed by private contractors at an annual cost of about $10,000. Dead animals are removed by the sanitary company. Mr. Gregory estimates the population and tonnages of various wastes as follows:—

	1905.
Population,	160,000
Street sweepings, tons,	57,300
Ashes, if natural gas were not used, tons,	64,000
Garbage, tons,	17,600
Rubbish, tons,	8,000
Manure, tons,	45,000
Night soil, tons,	3,900
Dead animals, tons,	350

Mr. Gregory would include "all refuse the accumulation of which would be uncleanly or unsightly, the production of which is practically universal, and the removal of which cannot be better and more economically performed by the individual."

He estimates the cost of hauling at thirty cents per ton-mile. The report discusses cremation at length and states that additional fuel must be used in order to attain the temperature necessary for the complete and satisfactory combustion of the refuse and garbage. The production of heat and power, therefore, is not considered possible. Rubbish sorting is also thought to be impracticable.

The report is very comprehensive, and while the estimates are somewhat higher than are usual in American practice, still one must consider that the work proposed is unusually comprehensive and the results which ought to be obtained are obtained economically in comparison with other localities. These estimates are as follows:—

Construction		$289,850
Operating Expenses, 1907,		
Fixed charges	$21,328	
Maintenance and operation	86,940	
Total Operating Expenses		108,268

Operating expenses per capita for collection and disposal of garbage and rubbish in 1907:—

	Fixed charges.	Maintenance and operation.	Total.
Collection of garbage and rubbish	$0.049	$0.305	$0.354
Disposal of garbage and rubbish ...	0.070	0.182	0.252
Disposal of night soil	0.002	0.007	0.009
Grand Total	$0.121	$0.494	$0.615

It is hoped that this scientific study of the problems at Columbus will result in the erection of a garbage disposal plant which will not repeat many unsuccessful attempts in other cities. It should also be taken into consideration that in England, where garbage cremation is most successfully carried on, the furnaces are operated by skilled workmen whose like does not exist in the United States.

WATER SUPPLY IN PHILADELPHIA. During the last few months the commission appointed to investigate the water filter contracts in Philadelphia has reported and as a result the contracts have been annulled. The commission also recommended water meters for the whole supply, and this position would seem to be justified by the facts. However, the City Council passed resolutions condemning the use of meters, saying that the unrestricted use of water was necessary to the health of the community. When it is taken into consideration that Philadelphia already wastes two or three times as much water as it uses, the position of the City Council would seem to be badly taken and based upon false assumptions, among them, that stating that water meters were yet an unsuccessful experiment, the contrary of which, from the experience with their use in other cities, is known to be true.

"Engineering News," March 22, 1906, page 337, comments upon this action of the Council and censures it for unwarranted extravagance, adding that gas, which is sold by meter, is no more expensive, volume for volume, than is water, and

that meters distribute the cost of waterworks service among those benefited in direct proportion to what they use and waste.

WISCONSIN PUBLIC WATER SUPPLIES.† This monograph is descriptive of the water supplies of the State of Wisconsin and should be valuable to those interested in such statistics. There are one hundred and twenty water supplies in the state. Fifty municipalities are supplied with artesian water; thirty with ground water; fourteen with lake water; twelve with river water, and for the remainder the supply is not definitely known. Three cities are supplied with river water purified by filtration, and four with lake water similarly filtered. The ground water supplies are more apt to fail than any of the others, and any serious trouble with the artesian water is due to excessive hardness and the presence of iron.

COLUMBUS SEWAGE DISPOSAL REPORT. Since the last issue of this Journal, the Report on the Sewage Disposal Experiments at Columbus, Ohio, which were conducted by Mr. George A. Johnson, has been published and distributed. This report is too voluminous to be reviewed in this Journal, but would well repay examination by any one interested in the details of this subject. The report recommends sedimentation of the sewage, followed by filtration through trickling filters at the rate of 2,000,000 gals. per acre per twenty-four hours, followed by sedimentation in suitable basins to remove the suspended matter. The aim of the proces is a non-putrescible, not a completely purified effluent.

WATER SUPPLY FOR THE CITY OF MEXICO.‡ The City of Mexico is now building a new water supply which will furnish clear, cold spring water of excellent quality and under ample pressure. The supply is to be brought to the city in a reinforced concrete conduit from a distance of twenty-seven kilometers. The water is elevated at the springs

†W. G. Kirchoffer, C. E., Bulletin No. 106, Engineering Series, University of Wisconsin.

‡"Engineering News," April 19, 1906, page 435.

sufficiently to permit it to flow to the city by gravity. At Chapultepec it is pumped into a reservoir near the historic battlefield of Molino del Rey. The work is partially completed and it is expected that it will be finished during the coming year.

SEWAGE DISPOSAL SUPERVISION IN ILLINOIS. The State of Illinois, which through its State Water Survey has for some years been collecting useful water supply data is, through the co-operation of this Survey and the State Board of Health, prepared to extend this investigation to the sewage disposal systems of the State.

AMERICAN RAPID WATER FILTERS ABROAD. Within the last two or three years a prominent American water filter company has installed water filters at Alexandria, Egypt, which have been commended by Dr. Bitte, who tested their efficiency. Recently filters of this type have been installed at Massourah, Egypt, and during 1904-05 the Prussian Institution for Investigating Water Supplies has studied a small experimental American or mechanical filter plant at the Mueggel See works of the Berlin Water Supply at Friedrichshagen. The inspector was Dr. Karl Schreiber. The experiments were similar to those conducted at various cities in this country, and similar conclusions were reached. In general the results were very favorable, although not so favorable as the results obtained with the muddy waters at Alexandria and Trieste. Dr. Schreiber commends the system where it can be used to advantage and recommends that in the future more attention be given to it in Germany. It should be noted in this connection that few of the German rivers are as muddy as most American rivers, although the Oder, Weser, Elbe and other rivers show turbidities which are too high for successful removal by the ordinary slow filters without coagulant.

WATER FILTRATION AND SOFTENING PLANT AT COLUMBUS, OHIO.* In America water softening plants are a rarity, the only large municipal plant being the one at Winnepeg. The admirable studies at Columbus have evolved the design of a combined water purification and softening plant which is not only unique but promises efficient and economical results. The water of the Scioto river is very hard and contains a relatively large amount of magnesia. The treatment prior to mechanical filtration is as follows:—

"First. The raw river water is first treated with a saturated solution of lime water to combine with all or nearly all of the free and half-bound carbonic acid and with the magnesia. This reduces the carbonate hardness and when the reduction is completed causes the lime to appear as a fine and more or less granular precipitate, while the magnesia separates out as a gelatinous precipitate which is a hydrate.

"Second. The above reaction takes place very slowly when the water is at rest, especially at winter temperatures. To complete the reaction promptly it is necessary to stir the water for an hour or so to give it a similar treatment. This is done by passing the water for about an hour through highly baffled mixing tanks in which it can be kept at a velocity of 0.3 to 0.5 ft. per second, as found desirable. In this way a large share of the resulting precipitates are held in suspension and the double purpose is accomplished of completing the softening reactions and of using the precipitates for coagulating the turbid water.

"Third. Some ten or fifteen minutes after the river water and lime water enter these lime mixing tanks a solution of soda ash is applied to reduce the sulphate hardness. This causes the lime to be converted into a normal carbonate which under the existing conditions is nearly insoluble. This reaction is also a slow one and is followed by the stirring which the water receives in the mixing tanks in the presence of the resulting precipitates. After the water has passed through the mixing tanks it is led to the settling basins hold-

*"Engineering Record," Feb. 24, 1906, page 202.

ing about twelve hours' flow at the full capacity of the plant. The basins are designed with several compartments to be used in series or in parallel, as found most effective in practice under the varying conditions. It is intended to remove the water from these basins and apply it to the filters as soon as the softening reactions are sufficiently completed and before the magnesia precipitate is entirely deposited. By this procedure it is expected that very little coagulant will be required,—probably none at all for months at a time. This use of magnesium hydrate as a coagulant is quite distinctly different from the lime treatment of the Ohio River in 1889 at Cincinnati, where the magnesia contents are too low to be of practical value. On the Lower Mississippi and elsewhere this process has apparently a field of usefulness.

"Fifth. When required, solutions of sulphate of iron or of sulphate of alumina may be added to the partially settled water to complete the coagulation of the water when unusually turbid.

"Sixth. When it is desired to remove the water from the settling basin and filter before the softening reactions are entirely completed, the last traces of caustic alkalinity (lime water) may be removed by mixing with the settled water a small percentage of raw river water and allowing the mixture to remain a few hours in the basins before filtration. This, of course, increases slightly the hardness of the softened and filtered water."

The features of this plant, of course, are its flexibility, the use of magnesium hydrate as a coagulant, and the addition of raw water for the purpose of removing the last traces of caustic alkalinity. Futhermore, the economy of combining the softening and coagulating processes marks a great step in advance in water purification. The plant has a nominal capacity of 30,000,000 gals. per diem, and the contract price was $524,209. The structure is an example of modern reinforced concrete construction.

COMBINED SEWAGE DISPOSAL AND REFUSE INCINERATION PLANTS AT MARION, OHIO.† Marion, O., has recently built a somewhat novel combination of sewage purification and refuse incineration plant. The sewage purification plant consists of three septic tanks, six contact beds of 5,000 sq. ft. each, and six sand disposal beds of 5,200 sq. ft. each. It is designed for 500,000 gals. per diem.

The incinerator is of the Walker type, 20x20x12 feet high. It consists of a combustion chamber, dust arrestor, and the usual devices for burning the products of combustion at a high temperature. The total plant cost $60,500. The whole plant is now being operated by one man, but it is expected that another man will be required when the amount of refuse is being collected for which the plant was designed.

COPPER IRON SULPHATE AS A COAGULANT FOR WATER PURIFICATION.* At Marietta, O., experiments have been made with the mechanical filters there using ferrous sulphate containing one per cent. of sulphate of copper, and lime as a coagulant. The bacterial results are very good, 99.33 per cent being removed on an average for the fifteen days. Out of the two hundred and twenty-eight samples of effluent taken during the test, thirty-two were sterile and forty-one contained only two bacteria per c.c. B. coli was found in two-thirds of the samples of raw water, but in none of the samples of filtered water. The effluent contained some caustic alkality. Mr. Brown, who conducted the experiments, attributes the results of the process to the bactericidal action of the copper sulphate. Inconsequent amounts of iron and copper only were found in the effluent.

STATE POTABLE WATER COMMISSION FOR NEW JERSEY. The Governor of New Jersey has formed a State Potable Water Commission, consisting practically of the State Riparian Commission and the State Geologist,

†"Engineering Record," March 17, 1906, page 358.
*"Engineering Record," March 24, 1906, page 392.

the latter official already having more or less to do with the water supplies of the state.

WASHINGTON WATER PURIFICATION PLANT.† The new Washington filters have been put in operation this winter and have been operating as slow sand filters without coagulant with fairly satisfactory results only. The turbid water, previously settled in basins, is not completely clarified by the filters. This water is difficult to treat without a coagulant, and a coagulant has been recommended by various investigators and by the designer of the plant, Mr. Allen Hazen. This treatment will be necessary for part of the year only. There is considerable opposition in Washington to the use of sulphate of alumina, and although a bill has been introduced in the Senate to permit its use, authority has not yet been granted. The bacterial efficiency of the filters while good is not remarkable, and would probably be improved if coagulant were used during the turbid seasons.

LABORATORY NOTES.

By Frederic P. Gorham,

Associate Professor of Biology, Brown University, and Bacteriologist, Providence Health Department.

THE PRODUCTION OF ACID AND ALKALI BY BACTERIA. E. O. Jordan, University of Chicago, reported as follows at the Ann Arbor meeting of the Society of American Bacteriologists:—

Since Theobald Smith's work in 1895 it has been known that the acid reaction that develops in the broth cultures of many bacteria is produced by the action of the bacteria upon muscle-sugar. It has not been definitely recognized, however, that there are other substances besides sugar in the ordinary nutrient media which, under the influence of bacterial activity,

†"Engineering Record," April 7, 1906, page 445.

lead to the production of a strongly acid reaction. One prominent text-book, indeed, affirms that "the formation of free acid is possible only upon nutrient media containing sugar." As a matter of fact, I have found the liquefaction of gelatin by bacteria or their sterile enzymes always gives rise to a marked acid reaction which may amount to as much as nine per cent. (*B. subtilis*) on the acid side of the phenolphthalein neutral point. A reaction of plus four per cent. is quite common in cultures of liquefying species. This is not surprising when it is remembered that substances like glycocoll and the amino-acids are conspicuous among the digestion products of gelatin. The simultaneous production of ammonia by bacteria tends to diminish the acidity of liquefied cultures, in some cases (e. g., *B. pyocyaneus* at 20° C) the acidity being nearly or quite overcome. The acidity is not confined to the liquefied area, but, as might be supposed, diffuses throughout the medium, altering the reaction of the gelatin at quite distant points. In nutrient agar, on the other hand, the diffusion of alkaline products alters the reaction of the medium in the opposite direction. A standard reaction for culture media, therefore, is valid only as an initial reaction. Gelatin and agar, inoculated with liquefying species, begin to diverge from the start and in a short time may become totally different. Bacteria make their own reaction in broth, gelatin and agar, and useful as a standard reaction may be, it has distinct limitations.

Some writers have attempted to establish a fundamental distinction between acid and alkali production by bacteria. Thus Gotschlich in Kolle and Wassermann's "Handbuch," 1, p. 100, expresses himself as follows: "In general it may be said that acid production always depends upon a splitting of sugar (or similar substances, like glycerine, etc.); while alkali formation is a synthetic process and stands in intimate causal relation with the growth and increase of bacteria." Such a view would seem to be eminently artificial, since the ammonia

to which an alkaline reaction is due is as truly a decomposition product of nitrogenous bodies as the amino-acids formed in the digestion of gelatin of the lactic acid in the fermentation of sugar. Both processes go on simultaneously, and the reaction of a culture medium in which bacteria are growing depends not only on the ability of the species to attack certain food substances, and on the chemical constitution of those food substances themselves, but also on the precise period of growth at which the reaction is tested.

EXPERIMENTS ON THE STAINING PROPERTIES OF BACTERIA WITH SPECIAL REFERENCE TO THE GRAM METHOD. Dr. D. H. Bergey of the University of Pennsylvania reported at the same meeting that careful search in text-books failed to reveal definite information as to the factors concerned in the Gram method of staining. There is even confusion in different text-books as to the properties exerted by the ingredients employed in the Gram method.

Investigation shows that the Gram reaction follows the employment of the pararosanilin dyes, especially the violet dyes of this group, such as crystal violet, menthyl violet, or mixtures of these known as gentian violet. The influence of the iodin is to form a new compound with the stained protoplasm of certain bacteria, which compound is insoluble or feebly soluble in alcohol. The alcohol serves as the decolorizing agent.

The exact difference in the chemical constitution between species of bacteria that stain positively and those that stain negatively by the Gram method is not definitely known, but the chemical constitution of the bacterial cell influences the behavior of the organism toward the Gram method.

Experiments along these lines are still in progress.

PREVENTIVE THERAPEUTICS.

By Herbert D. Pease,

Director Antitoxin Laboratory, State Department of Health, Albany, N. Y.

PREVENTION OF TETANUS. The contribution on the use of tetanus antitoxin in France for the prevention of tetanus in horses and animals, published under the Section of Veterinary Sanitation in the last number of this journal, should still further impress American surgeons, practitioners, and public health officials with the need for making a regular practice of administering preventive doses of tetanus antitoxin in all cases of injuries when there is the slightest possibility that any unsterilized foreign body, or substance, has been carried into the wound, and either cannot be removed or has been allowed to remain in the tissues for a time.

The tetanus bacillus grows only in the absence of oxygen, but there are a variety of natural conditions under which the anaerobic condition is brought about. Thus, wounds of parts poorly supplied with blood, or in which the tissues are so destroyed as to impede or stop the circulation of fresh blood, or in which other micro-organisms capable of using up the available oxygen flourish, render possible the development of the tetanus bacillus if it has been carried into the tissues during such injuries.

The tetanus bacillus has a wide-spread habitat, but it is very common in garden dirt, manure, etc. It is undoubtedly present on the skin of many individuals, for many cases develop from injuries inflicted in such a manner that the clothing over the part is not torn.

Even apparently clean wounds which have healed by first intention have been followed by tetanus in some cases. This can be accounted for by the fact that the tetanus bacillus does not produce suppuration and if pyogenic bacteria are absent there may be no evidences of any infection. A very slight

development of the bacillus is sufficient to produce many human fatal doses of tetanus toxin.

The toxin is transmitted to the central nerve cells, upon which it exerts its toxic action, only through the peripheral nerve terminals and the axis cylinders of the motor nerves. After the toxin has been absorbed by the nerve terminations and is in the nerves, it is unaffected by any antitoxin present in the circulating blood. If, however, the antitoxin has been administered in advance of the absorption of the toxin by the nerves, complete neutralization of the poison takes place in the blood and no tetanic poisoning follows.

All the practical results from the use of tetanus antitoxin as a preventive agent support this statement. Tetanus infection has never developed subsequent to the administration of a preventive dose of tetanus antitoxin in this country. The practice of using such doses in all suspicious injuries at the time of dressing has become very general in the hospitals and dispensaries in some sections of the country, and their experience in this direction, in what must already be thousands of cases, entirely supports the statement that tetanus antitoxin administered soon after the infliction of an injury affords perfect protection from tetanus.

For small injuries a dose of ten to twenty cubic centimeters should be administered subcutaneously. In extensive injuries with laceration of muscles, antitoxin, in either the liquid or dried form, should be used locally in addition to the subcutaneous injections. This local use is intended to protect the ends of any torn nerve trunks from the absorption of toxin directly from the site of injury.

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